

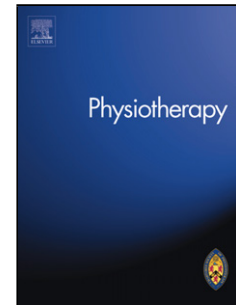
## Accepted Manuscript

Title: Experience of an upper limb training program with a non-immersive virtual reality system in patients after stroke: a qualitative study

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PII: S0031-9406(17)30021-4  
DOI: <http://dx.doi.org/doi:10.1016/j.physio.2017.03.001>  
Reference: PHYST 956

To appear in: *Physiotherapy*



Please cite this article as: Lehmann Isabelle, Baer Gillian, Schuster-Amft Corina. Experience of an upper limb training program with a non-immersive virtual reality system in patients after stroke: a qualitative study. *Physiotherapy* <http://dx.doi.org/10.1016/j.physio.2017.03.001>

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# Experience of an upper limb training program with a non-immersive virtual reality system in patients after stroke: a qualitative study

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*This work was undertaken while Isabelle Lehman was a post graduate student at Queen Margaret University, Edinburgh under the supervision of Dr Baer*

*Word count: 4848*

## Abstract

**Objectives** The YouGrabber (YG) is a new virtual reality training system that focuses on unilateral and bimanual activities. This nested study was part of a larger multicentre randomised controlled trial and explored experiences of people with chronic stroke during a 4 week intensive upper limb training with YG.

**Design:** A qualitative design using semi-structured, face-to-face interviews. A phenomenological descriptive approach was used, with data coded, categorized and summarized using a thematic analysis. Topics investigated included: the experience of YG training, perceived impact of YG training on arm function, and the role of the treating therapist.

**Results:** Five people were interviewed (1 female, age range 55-75yrs, 1-6yrs post-stroke). Seven main themes were identified: (1) general experience, (2) expectations, (3) feedback, (4) arm function, (5) physiotherapist's role, (6) fatigue, (7) motivation. Key experiences reported included feelings of motivation and satisfaction, with positive factors identified as challenge, competition, fun and effort. The YG training appeared to trigger greater effort, however fatigue was experienced at the end of the training. Overall, patients described positive changes in upper limb motor function and activity level, e.g. automatic arm use. While the opportunity for self-practice was appreciated, input from the therapist at the start of the intervention was deemed important for safety and confidence.

**Conclusions:** Reported experiences were mostly positive and the participants were motivated to practice intensively. They enjoyed the challenging component of the games.

**Keywords:** Chronic stroke, upper limb recovery, non-immersive, virtual reality, semi-structured interview, phenomenology

## Introduction

Virtual reality (VR) is increasingly used in neurorehabilitation to encourage purposeful movement of the limbs or the whole body in simulated environments. VR has been defined as "... a way for humans to visualize, manipulate, and interact with computers and extremely complex data" [1]. Two types of VR technology exist: 1. Immersive VR technology enables the participant to move in a computer-generated simulated world, most of the time as an avatar and 2. Non-immersive VR technology which uses game systems with a 3D graphic environment [2]. Users can use keyboard, mouse, or other game interface devices to interact with and navigate in the on-screen virtual environment [2].

The advantages of virtual non-immersive systems are numerous: users can view and modify their movements in real time and can perform tasks that might be too difficult in the real world. Advantages of VR include: reduced intervention costs, opportunities for intensive and varied practice, customized exercise protocols, the ability to monitor exercise performance and increased user motivation [3, 4]. However, in chronic stroke populations, there is limited evidence concerning the effectiveness of including VR technology as part of upper limb functional rehabilitation. A Cochrane review showed moderate-quality evidence of VR effectiveness in improving arm function [5]. However, the lack of homogeneity, small sample sizes, differences in the outcome measures used, and the different training protocols limit generalisable treatment recommendations. Insofar, optimal VR characteristic supporting a long term usage are lacking as well [6-8].

While the direct influence of VR technology on motor function is not well understood, a positive impact on cortical reorganisation has been demonstrated [9]. It has been proposed that the goal-directed tasks coupled with performance feedback enhances neuronal network activity and activation of the mirror neuron system and, therefore, positively influences neuroplasticity [10-13].

Exploring the acceptability of new technologies in rehabilitation is crucial. There is some evidence that users are motivated to use a VR training system [13-18]. In a small study with 4 participants, authors stated that factors positively influencing performance include concentration, challenge, player skills, control, clear goals, feedback immersion and social interaction [19].

However, it has also been reported that users tend to expect challenging games options and that a more complex haptic interface seemed to be better accepted due to the more challenging scenarios that could be provided [13]. Furthermore, Saposnik et al. mentioned that recreational activities might be as effective as upper limb training with non-immersive VR technology [20].

Studies exploring the experience of using VR have shown methodological limitations, for example using questionnaires does not allow a detailed understanding of users' experiences or what aspects of VR are enjoyable [17, 18].

Furthermore, some other aspects have not been explored in depth: (a) From a therapist perspective, it is not clear if patients lose motivation after a certain period of time or for how long users are willing to practice with a VR-based training system. (b) It could be argued that people after stroke, who tend to be older, may be sceptical about using new and unfamiliar technology [3, 21].

The YouGrabber® (YG) is a new VR training system that trains uni- or bi-manual tasks [22] (see figure 1). YouGrabber® was created by engineers and neuroscientists and provides three feedback modalities (acoustic, visual and sensory) to facilitate performance adaption. The device was developed specifically for arm, hand and finger movements only. It allows detecting and displaying even small movement changes. Furthermore, three different treatment modes are available to train the affected upper limb: (a) normal (left/right real hands control their virtual counterparts), (b) virtual mirror therapy (one real hand controls both virtual arms, the contralateral virtual hand in a mirrored fashion), or (c) virtual following (as for virtual mirror therapy, but without mirroring).

YouGrabber® has been tested in paediatric patients and on people with stroke using single case studies [23, 24]. Promising results concerning the therapeutic efficacy became obvious, however, the sample sizes were too small to allow final conclusions with sufficient power.

The views, experiences and expectations of YG users have not been previously explored. In the United Kingdom, it is a goal of the legislation to improve personalised care using the participant's voice in research [25]. Virtual reality is still very young training intervention. To develop and enhance such technologies it is important to evaluate the user perspective.

This present study therefore aimed to look at the lived experiences of people with chronic stroke with experience of intensive practise with the YG training system.

## Methods

### *Study design and ethics approval*

An exploratory qualitative study design using a phenomenological approach was used. The involvement of user's in the development of VR games for rehabilitation is fundamental [17]. In the context of human science, phenomenology can be used to describe the experiences of people [26]. From a philosophical point of view phenomenologists look at the phenomenon with a critical and objective position whereas phenomenology used as a scientific approach looks at a subjective experience of the people investigated [27]. In Husserl's phenomenology, the description of the phenomenon is the primary focus followed by an interpretation [28]. The present exploratory study and analyses remained at a descriptive level and did not aim to interpret patients' views. We used a qualitative design and phenomenological analysis approach to explore and get an insight into the experiences of a group of patients after stroke in the chronic stroke stage using language as data. That approach enabled a better understanding of subjectivity [29].

The researcher had a realistic positionality and used an inductive technique to conduct all interviews at the Reha Rheinfelden and the University Hospital Inselspital in Bern (Switzerland), where the VR training was applied. The researcher did not know the patients before the interview.

All participants were interviewed by the first author, using open-ended questions in semi-structured interviews. The interview guide can be obtained from the first author.

The following topics were investigated:

- 1) The general experience with the YG training system
- 2) The influence of the YG on their arm function

### 3) The role of the physiotherapist during the YG intervention.

The interviewer a 40 years old female physiotherapist, with 15 years experience in neurorehabilitation) did not know the participants prior to interview. The COREQ checklist has been used to report all study details.

The presented study required ethical approval from three committees: ethical approval was received from the responsible Swiss ethics committee of the Canton Aargau and Solothurn (application number: 2012/065) and the ethics committee of the canton Bern (application number: 220/12). In addition, ethical approval was granted by the Queen Margaret University Divisional Research Ethics Committee (19.12.2012).

#### *Participants' selection criteria*

Potential participants were informed about the study in written and oral form and were recruited from two rehabilitation centres in the German speaking part of Switzerland using a convenience sampling [30].

Inclusion criteria ensured participants were at least six months post first-ever ischemic or haemorrhagic stroke and, were randomised into the YG training group and not to the conventional therapy group in the larger multicentre randomised controlled trial: Effectiveness of the YouGrabber® system using virtual reality in stroke rehabilitation: a single blinded, randomised controlled multi-centre trial RCT's [22]. The time period criterion was chosen because patients were considered to be in the chronic phase after stroke. A time period, when other therapeutic interventions started to be diminished and an interaction effect with other therapies would be



avoided.

We aimed to include up to 10 patients. However, due to time constraints and slow recruitment for the RCT the targeted sample size could not be attained.

All participants had completed at least eight out of 16 YG training sessions and were able to communicate. All patients received the standardized study patient information sheet with information on the YouGrabber technology. Furthermore, therapists were instructed to introduce all games within the first two training sessions and to play at least three different games per training. Patients were excluded if they participated in another study or had severe communication difficulties. All participants gave written informed consent.

#### *Interview guide and study preparation*

The interview guide was developed from the first author based on previous research and was adapted with the help of both co-authors [31, 32]. Two videotape-recorded familiarisation interviews were conducted by the first author (IL) to improve interview technique, ensure familiarity with the process, and adapt the interview guide. After both familiarisation interviews no adaptations were necessary. During the actual one-to-one interviews, IL followed the interview guide, was open-minded and set aside personal beliefs and values [33, 34]. The interviewer kept a reflexive research diary and at the end of each interview field notes were recorded [32].

#### *Data processing and validity check*

An inductive data analysis using thematic analysis was performed integrating the six stages proposed by Braun and Clarke (Table 2) [35]. During transcription every

participant was assigned a pseudonym. To check validity, three randomly chosen original audiotape extracts, were given for a translation accuracy check to a German speaking Scottish physiotherapist living and working in Switzerland for 30 years. A member-check was undertaken by returning the transcripts to the participants to check the transcription and make comments if needed [36]. Transcripts were read and re-read, themes and sub-themes identified by cutting and pasting quotes onto themes sheets. The identified themes were then discussed (IL, GB) to assure dependability of interpretation.

## Results

Data were collected between February and July 2013. Demographic data and participant's characteristics are presented in Table 1. The targeted sample size of 10 patients could not be attained due to time constraints and slow recruitment for the RCT. Five participants (age range 55-75 years; 2 right, 3 left hemiparesis; 1 female;) with chronic stroke (one to six years post-stroke) were recruited. By the agreed interview date, all patients completed all 16 scheduled training sessions. Interviews lasted between 30 to 45 minutes. During the analysis two master themes with seven themes were identified (Table 3): (1) general experience (2) expectations, (3) feedback, (4) arm function with the subthemes improved impairments and functional benefits, (5) role of physiotherapist with the subthemes human interaction and control and safety, (6) fatigue, and (7) motivation with the subthemes novelty, challenge, effort, fun, and customisation. Themes 1 to 5 could be allocated to master theme (a) YouGrabber® intervention: medical and clinical elements. Themes 6 and 7 could be allocated to master theme (b) YouGrabber® intervention: social and personal elements.

The following section presents every theme and subthemes, and cites quotations to underlie the results.

*Theme 1: General experience with the VR training system*

Most of the participants enjoyed using the YouGrabber and described it as ‘very interesting’ and ‘easy to use’. They liked the training (e.g. competitive character of the games, visual feedback, training report summary) and indicated willingness to pursue the practice over a longer period of time. When exploring potential concerns participants may have had prior or during the intervention, no issues were raised.

*Theme 2: Expectations of the VR training system*

Although, participants had a long history of living with stroke, all were expecting arm motor function improvements after the training. Some of them wanted the games to be more challenging

*‘Yes, it just needs to be something when you need to think a lot, nothing easy actively, but where you need to think’.* (Heidi).

An important point identified was the use of the YG as a therapy adjunct. Stated

*‘As for the use of such a machine for training at home, you can’t do much wrong because the computer controls everything, it has the programmes and when you choose a game then, it doesn’t deviate from the given ranges and it also gives you the limits of what is tolerable and what not’.* (Roger).

Improvements to the YG training system identified by participants included minor system adaptations, e.g. reductions in game delay when doing movements.

### *Theme 3: Feedback with the VR training system*

The YG feedback modalities were appreciated.

*'One can see what one's achieving and that one is improving over the training, and for me personally it makes me feel better'* (Fritz). Participants also identified that the feedback helped them adapt and fine-tune their performance

*'When you make a mistake, you can hear the alarm signal, you register it and you know you don't want that'* (Roger).

*'I can learn to move more precisely with this system'* (Heidi).

The YG system also offers a performance summary at the end of every game and some participants evaluated their own performances using the end scores.

*'That's important for me, so if I reached 95% or 50%, that's a difference for me, and I have always had good result up to now'*. (Heidi). The precision of the measures (in seconds) was appreciated and Roger found it easy to follow. He described the computer as being *'tough'* and he liked the fact that the results were given with zero tolerance - a *'right or wrong'* manner.

### *Theme 4: Arm function with the VR training system*

Overall the participants noted reductions in arm impairment and experienced functional benefits (Preliminary findings are reported elsewhere [37]).

*Sub-theme 4.1 'Improved impairments'*. For example, Fritz declared that he felt stronger and his arm was less stiff.

*Sub-theme 4.2 'Functional benefits'*. Importantly, functional benefits and more precise movements were described by some participants with an increase in

automatic arm use in daily life and the increased success in particular activities. Heidi explained that before the YG she tended to *'...let my arm hang on my side'*, now, however she noticed changes:

*'So I'll have to say, there are sometimes things, which are suddenly possible, it seems that I use my arm better than I think'*. (Heidi).

Improved movement and automaticity was reported by several participants e.g. improvement in *'grasping'*, *'reaching'* or *'lifting things'* influenced important activities such as dressing or housework.

*'Yes, I can't say that, owing to the fact that I use the hand more automatically, holding something, and then I surprise myself 'Oh! I am holding something with this hand'. That shows me that automatic movements are coming back very slowly'*. (Heidi).

Roger was very happy stating that he could *'hold a newspaper'* or *'read a book'* easier than before.

#### *Theme 5: The role of the physiotherapist with the VR training system*

The therapist's presence was considered crucial at the start of the training period. It was recognized that help was needed to start the training system, explain the games, and calibrate the system. Another aspect was the importance of having someone monitoring the changes over time.

*Sub-theme 5.1 'Human interaction'*. Social interaction was appreciated, Tom said:

*'With the therapist one can laugh, and have fun, talking about different stuff besides the training'*.

Sometimes the therapist was seen as a ‘coach’ not only during one session but also over the whole training period. The participants valued having someone looking at emerging problems and their solutions at the right time.

*‘One has a complete paralysis, there are so many problems and there is always something new coming up. As soon as you show some improvements you have to adapt your goals. I think this builds up a relationship between the therapist and the patient. This in my view, puts the therapist in a coaching role’.* (Roger).

*Sub-theme 5.2 ‘Control and safety’.* The therapist’s role was also described as being in ‘control’ of the movement quality, performance set up, and as the machine operator. It was reported that during the training, participants could fully focus on the game knowing that someone beside them would control the situation and give feedback if needed. The dimension of ‘control’ seemed to be related to individual needs during performance. Hans struggled with practice exertion during the training and said:

*‘Without that, I move around and exhaust myself because I am so tense, then when I am aware of it, it is too late’.*

#### *Theme 6: Fatigue due to the VR training system*

Some participants found the repetitive tasks demanding ‘*It is exhausting*’ (Roger). Fatigue was highly individual and sometimes related to a decline in performance. Roger described it like this:

*‘After a while, you notice your concentration is lessening, then you make more mistakes, this can be seen clearly’.* Signs of fatigue were described using terms like ‘*clumsiness*’ and ‘*stiffness*’ and were perceived at different levels. Fritz said:

*'Yes, now and then, it is quite tired, and then nothing is possible or it is more difficult, it starts to tremble.*

However, the patients mentioned fatigue but it was difficult to differentiate between mental or physical fatigue.

#### *Theme 7: Motivation with the VR training system*

The theme 'motivation' was related to five sub themes: 'novelty', 'challenge', 'effort', 'fun', and 'customisation' that are described below.

*Sub-theme 7.1 'Novelty'.* YouGrabber was described as highly motivating because of its novelty. All participants had been receiving occupational therapy and physiotherapy for a long period of time and there was common opinion that they expected more improvements and greater functional benefits with YG. Patients hoped this 'new' technology might have an additional impact on recovery. It is important to mention here that the interviewees had no or only marginal experience with VR. As described by Roger:

*'At first, because it is something new, completely new, I am quite open to it, you always have hope that it will bring you further on'.* So the novelty factor might be related to the expectations of increased motor function.

*Sub-theme 7.2 'Challenge'.* Another positive aspect was the challenge due to competition against the computer.

*'Yes, you start with motivation but there is also the factor of the challenge of playing against the computer'.* (Roger).

Several people wanted to win the game and liked the confrontation with a computer

*'I can say that I am exercising with the same joy and spirit, because I want to win against the computer or reach the prescribed time'. (Hans).*

Roger talked from the past perspective of being a sportsman. For him, the *'intensity'* of practice made the intervention challenging and this sparked his competitive spirit. During conventional therapy he reported less pressure and could stop therapy more easily, however

*'When the computer sends a new object you have to catch, you just think I'll manage that one too' (Roger).* Heidi also appreciated the challenge of being forced to use her weak arm.

*'Because it is difficult, and here I really have to use my arm, I try to do this at home too, it is not that I don't do anything at home, I try to use it when holding or lifting, I do that too, but I think here I am really challenged to use my arm, I like that'. (Heidi).*

Patients were willing to practice for a longer time and to use it at home, but at that time the setting did not make this possible.

*'Yes, I would use it everyday, every time, as long as I could. I would do that, I would be very happy if this would be possible. ' (Heidi).*

*Sub-theme 7.3 'Effort'.* The level of motivation was also perceptible through comments concerning the effort of practice. Participants were very committed to the intensity of practice, thus it was relevant to look into the factors and reasons for this effort. Some of the participants felt it *'dramatically challenging'* when being confronted with a high training intensity.

When discussing performance or practice intensity Heidi found she needed a high level of *'concentration'* and the ability to *'focus'* on the task. She enjoyed exercising her arm in *'every direction'* without any help.



A key difference identified between conventional therapy and the VR system was that the intensity was pre-ordained by the computer and therefore, better accepted with limited ability to reduce the intensity.

*'I always view it as more intensive than conventional therapy. In conventional therapy, there is always a possibility to distract the therapist'. (Roger)*

Experiencing success during the games was a driver to practice more. The fact that participants saw their scoring during the games and received a performance summary after each game influenced them in their effort.

*'I exercised more intensively because I could see what I was doing'. (Fritz)*

*Sub-theme 7.4 'Fun'.* Interviewees described the VR training as being motivating because it was *'fun'* and *'playful'*.

*'It might be the same as for a child maybe, something new, a toy, yes I saw it as a toy you can experiment with, and there are several possibilities, so in a sense I was hoping it offers new exercise options and in my opinion that is the case'. (Roger).*

*Sub-theme 7.5 'Customisation'.* Another motivational aspect was the fact that the participants could watch their movements on screen.

*'So, I can see this and I find it interesting, I cannot open my hand myself, but the computer does it. When I am grabbing something, then I can see it is working, although the hand is not open. That is very interesting, I wonder how this works'. (Heidi)*

When comparing the YG training to conventional therapy, it appeared that the participants felt less frustrated. Hans stated:

*'So, yes, it starts as soon as I have to grab a pen. I can try it like this, but I have problems. Small objects for example, that drives me crazy. And with the YouGrabber the problems are less, because you can use three fingers, all the fingers or the hand to do it. This makes it possible. But, when you have to grab single things, like this. This makes me crazy'.*

## **Discussion**

The aim of the study was to get an insight into the lived experience of patients in the chronic stage after stroke undertaking VR-based upper limb training. Following five semi-structured interviews, seven main themes emerged as identified: (1) general experience, (2) expectations, (3) feedback, (4) arm function, (5) physiotherapist's role, (6) fatigue, (7) motivation. Our findings corroborate results from some previous work that patients felt enthusiastic when training with VR [17]. Furthermore, we identified some novel and important insights.

### *Theme 1: General experience with the VR training system*

Most of the patients enjoyed using the YouGrabber, found it easy to use, and had no concerns or safety issues. They understood the VR training system as an option to practice intensively in a playful manner. Patients were convinced that the VR training would be a therapy adjunction. They understood the VR system as a technology against they were competing and they wanted to win. Seeing the VR system as just a machine, they felt less pressurised practising with it. In OT or PT therapy they had the impression that the training was less intense but covered other aspects as well, e.g. manual techniques for mobilisation or more specific strength training.

*Theme 2: Expectations of the VR training system*

Participants considered Yougrabber® was a good therapy adjunct and expected the intervention would enhance motor improvement. In their view, the system should be to be more operational and stable in order to use it at home. This is in accordance with other research done in that field bringing evidence that the 'ease of use' is one of the first expectations [38, 39].

*Theme 3: Feedback with the VR training system*

The multiple feedback modalities offered by YG elicited a variety of views. Some interviewees preferred 'scores' while others focussed on changes in arm performance during the game. Providing 'scores' as a feedback mode needs further evaluation as therapists have to be able to explain the score to allow improvements from the VR training to transfer to reality.

*Theme 4: Arm function with the VR training system*

The YouGrabber training system allowed repetitive and intense practice of upper limb tasks and participants reported improvements in their ADL performance for example in grasping and holding modalities. As mentioned the presented study was a nested qualitative investigation in an ongoing single blinded, randomised controlled multi-centre intervention trial, the outcomes measures of which were used to evaluate upper limb function. However, results of that quantitative part were not completely analysed so far and will be reported elsewhere [22].

*Theme 5: The role of the physiotherapist with the VR training system*

The positive impact of the *role of the physiotherapist* was an important finding. While VR training cannot replace practise with an experienced physiotherapist, it can provide an important adjunct [40]. Participants required a therapist at the beginning of the training for safety and also appreciated therapist feedback on movement quality, performance, and help with problem solving. In agreement with Flores et al. we also identified the importance of involving skilled therapists during VR training [41]. Recent research found that there is still concern about poor movement quality in VR [39] and the necessity or not of supervision during exercise

#### *Theme 6: Fatigue due to the VR training system*

A further new insight from the present investigation was the feeling of *fatigue*. Terms such as “*clumsiness*” or “*fatigue*” were linked to an increased number of game mistakes. These aspects of practice and effort and fatigue have been poorly investigated to date, although it may be a major issue in VR use. Recent publications showed evidence for a link between diminished motor cortical excitability, slowing movement speed and fatigue in stroke patients [42]. However, authors argued that game background, colours and illustrations affects participants performance [43]. These domains should be evaluated separately.

#### *Theme 7: Motivation with the VR training system*

In the present study, it became obvious that *motivation* was related to a number of sub-themes. Motivation was enhanced because the participants liked the games, the adaptability of the YG to their level of performance, and they were willing to practice with effort.

When looking at the *novelty* factor, two aspects emerged.

Firstly, *novelty* could be related to the fact new technology may possibly be seen by the user's as being more effective [17]. We found however, that *novelty* was related to a feeling of hope and expectations of functional benefits from an intervention they had never used before. Furthermore, the interviewees expressed that they had tried so many different training options in the past but their expectations concerning improvement and functional benefits were still not achieved. They 'wanted more' and were still seeking for a 'new chance' to increase recovery and improve function. Patients hoped that the training with this new technology might provide additional benefit.

Secondly, participants were willing to exert more *effort* and had identified the physical and cognitive challenges when playing the games. These findings are important since they show that important fundamental rehabilitation principles can be adhered to with the YG training system, e.g. tasks need to be meaningful and practiced with high intensity tasks are adjustable to the participants' motor function level, are repetitive, hierarchical, and involved feedback [2, 44-47].

### *Limitations of the study*

While every effort was made to undertake the work in an unbiased manner using rigorous methodology, there are some limitations. The results of the present study are based on a small sample size of five interviewees. However, consensus was achieved across all five patients.

Furthermore, one-to-one interviews may limit the ability of the participant to be critical. However, this may have been reduced, as the interviewer was not previously known to the participants. Interviews do allow personal opinions to be aired without

contamination from others views such as in a focus group and can allow deep exploration of issues [48]. As more than one clinic was involved and participants came from a wide geographical area this means the results are not limited to experience from one site

The interviews were conducted while YG training was on-going and therefore no conclusion can be drawn regarding the long-term use of VR in chronic stroke.

Methodologically, the different stages of translation stages during analysis may have affected trustworthiness, however this was minimised by having a bilingual external person check accuracy for all translation steps [49, 50].

We only included patients after their first-ever stroke. That selection criterion was due to participation in the larger study. We could only include patients, who participated in the larger multi-centre RCT to make sure that all patients received the same amount of therapy by specifically trained therapist.

We did not investigate adherence in this study as the VR training system was well accepted and all patients assiduously performed their training sessions.

## **Conclusion**

General experiences of patients after stroke using the YG were perceived as positive. The participants were motivated to practice intensively, liked the challenging component of the games and reported positive changes in their arm function and ADL related changes. The use of the VR training system is safe and seems to be a motivating training option for patients after stroke. Therapists using YouGrabber should be aware of the importance of monitoring fatigue and be cautious with feedbacks using scores.

The present study revealed some new insights in experience with a new VR training system for the rehabilitation of the upper limb, e.g. feedback modalities.

Further research should evaluate aspects related to VR trainings, e.g. the origin of fatigue, the severity of the symptoms, and impact on the participant's ability to learn. While the participants in this study used the YG in a clinic, it would be feasible to use YG at home. Further investigations into that experience would be reasonable.

### **Funding**

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

### **Competing interests**

The authors declare that they have no conflicts of interests.

**Ethical Approval** was received from the responsible Swiss ethics committee (Application Number: 220/12) and from Queen Margaret University Divisional Research Ethics Committee.

### **Acknowledgements**

The authors are grateful to the participants and their relatives, to the physiotherapists, and health practitioners for contributing to this study. Furthermore, we would like to thank Nancy Frljic for reviewing and checking the accuracy of transcript translations.

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Figure 1



Table 1: Demographic data and participants characteristics

| Case      | Transcri<br>pt<br>Time /<br>Pages  | Se<br>x | Ag<br>e | Occupatio<br>n      | Date of<br>CVA | Time<br>since<br>stro<br>k<br>e | EBI       | MMS<br>E | Hem<br>i<br>Side | Han<br>d<br>dom<br>. |
|-----------|------------------------------------|---------|---------|---------------------|----------------|---------------------------------|-----------|----------|------------------|----------------------|
| Hans      | Time:<br>00:34:49<br>Lines:<br>206 | M       | 58      | Shift<br>supervisor | 04.06.1<br>2   | 1y                              | 60/6<br>4 | 27/30    | Left             | Righ<br>t            |
| Tom       | Time:<br>00:35:49<br>Lines:<br>270 | M       | 63      | Architect           | 27.12.0<br>9   | 3y                              | 64/6<br>4 | 30/30    | Righ<br>t        | Righ<br>t            |
| Fritz     | Time:<br>00:28:08<br>Lines:<br>277 | M       | 55      | Bus driver          | 02.04.1<br>1   | 2y                              | 42/6<br>4 | 29/30    | Left             | Righ<br>t            |
| Roge<br>r | Time:<br>00:40:26<br>Lines:<br>306 | M       | 67      | Designer            | 28.09.0<br>7   | 6y                              | 64/6<br>4 | 29/30    | Left             | Righ<br>t            |
| Heidi     | Time:<br>00:34:16<br>Lines:<br>254 | F       | 75      | Secretary           | 11.07.0<br>8   | 5y                              | 64/6<br>4 | 28/30    | Righ<br>t        | Righ<br>t            |

Legend: CVA: cerebrovascular Insult, EBI: Extended Barthel Index, MMSE: Mini-Mental-State-Examination, Hemi. Side: affected body side, Hand dom.: hand dominance.

Table 2: Phases of Thematic Analysis adapted from Braun and Clark (2006).

| Description of the process |                                      |  |
|----------------------------|--------------------------------------|--|
| Stage 1                    | <b>Familiarisation with the data</b> | Data transcription<br>Read and re-reading the data<br>Note down initial ideas  |
| Stage 2                    | <b>Generating initial codes</b>      | Code interesting features of the entire data systematically<br>Collate data relevant to each code                            |
| Stage 3                    | <b>Searching for themes</b>          | Order codes into potential themes<br>Gather all data relevant to each potential theme  |
| Stage 4                    | <b>Reviewing themes</b>              | Check if the themes work in relation to the coded extract and the entire data set<br>Generate thematic 'map' of the analysis |
| Stage 5                    | <b>Defining and naming themes</b>    | On-going analysis to refine the specifics of each theme<br>Generate clear definition and names for each theme                |
| Stage 6                    | <b>Producing the report</b>          | Final opportunity for analysis of selected extracts<br>Selection of vivid extracts examples                                  |



Table 3: Thematic analysis map.

| Master theme  | Themes                  | Sub-themes           |
|---|-------------------------|----------------------|
| YouGrabber® intervention:<br>Medical and Clinical<br>elements | General experience      |                      |
|   | Expectations            |                      |
|   | Feedback                |                      |
|   | Arm function            | Improved impairments |
|   |                         | Functional benefits  |
|   | Role of physiotherapist | Human interaction    |
|   |                         | Control and safety   |
| YouGrabber® intervention:<br>Social and Personal<br>elements  | Fatigue                 |                      |
|   | Motivation              | Novelty              |
|   |                         | Challenge            |
|   |                         | Effort               |
|   |                         | Fun                  |
|   |                         | Customisation        |